TACCIMO Literature Report
Literature Report – Annotated Bibliography Format
Report Date: April 1, 2013

Content Selections:
FACTORS – Extreme Weather
CATEGORIES – Tropical Cyclones
REGIONS – National, East, R9: Eastern, North Atlantic, R8: Southern, South Atlantic, South Central

How to cite the information contained within this report

Each source found within the TACICMO literature report should be cited individually. APA 6th edition formatted citations are given for each source. The use of TACCIMO may be recognized using the following acknowledgement:

"*We acknowledge the Template for Assessing Climate Change Impacts and Management Options (TACCIMO) for its role in making available their database of climate change science. Support of this database is provided by the Eastern Forest Environmental Threat Assessment Center, USDA Forest Service.*"

Best available scientific information justification

Content in this Literature report is based on peer reviewed literature available and reviewed as of the date of this report. The inclusion of information in TACCIMO is performed following documented methods and criteria designed to ensure scientific credibility. This information reflects a comprehensive literature review process concentrating on focal resources within the geographic areas of interest.

Suggested next steps

TACCIMO provides information to support the initial phase of a more comprehensive and rigorous evaluation of climate change within a broader science assessment and decision support framework. Possible next steps include:

1. Highlighting key sources and excerpts
2. Reviewing primary sources where needed
3. Consulting with local experts
4. Summarizing excerpts within a broader context

More information can be found in the user guide. The section entitled Content Guidance provides a detailed explanation of the purpose, strengths, limitations, and intended applications of the provided information.

Where this document goes

The TACCIMO literature report may be appropriate as an appendix to the main document or may simply be included in the administrative record.

Brief content methods

Content in the Literature Reports is the product of a rigorous literature review process focused on cataloguing sources describing the effects of climate change on natural resources and adaptive management options to use in the face of climate change. Excerpts are selected from the body of the source papers to capture key points, focusing on the results and discussions sections and those results that are most pertinent to land managers and natural resource planners. Both primary effects (e.g., increasing temperatures and changing precipitation patterns) and secondary effects (e.g., impacts of high temperatures on biological communities) are considered. Guidelines and other background information are documented in the user guide. The section entitled Content Production System fully explains methods and criteria for the inclusion of content in TACCIMO.

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Effects by Source

Monday, April 01, 2013

RESOURCE AREA (FACTOR): EXTREME WEATHER

TROPICAL CYCLONES

NATIONAL

Beckage, B., Gross, L. J., & Platt, W. J. (2006). Modelling responses of pine savannas to climate change and large-scale disturbance. Applied Vegetation Science, 9, 75-82.

"In addition, if the current relationship between ENSO [El Niño/La Niña-Southern Oscillation] and NAO [North Atlantic Oscillation] remains intact with global warming, then the hurricanes that do form will be more likely to track toward the northeastern rather than the southeasterncoast of the U.S.."

Day, J. W., Christian, R. R., Boesch, D. M., Yбcaz-Arancibia, A., Morris, J., Twilley, R. R., … & Stevenson, C. (2008). Consequences of Climate Change on the Ecogeomorphology of Coastal Wetlands. Estuaries and Coasts, 31, 477-491. doi: 10.1007/s12237-008-9047-

"Emanuel (2005) reported that sea surface temperatures in the tropics increased by about 1 C over the past half century, and during this same period, total hurricane intensity or power increased by about 80%."

Emanuel, K. (2005). Increasing destructiveness of tropical cyclones over the past 30 years. Nature, 436, 686-688. doi: 10.1038/nature03906

"My results suggest that future warming may lead to an upward trend in tropical cyclone destructive potential, and-taking into account an increasing coastal population- a substantial increase in hurricane-related losses in the twenty-first century."

Nicholls, N. & Alexander, L. (2007) Has the climate become more variable or extreme? Progress 1992-2006. Progress in Physical Geography, 31(1), 77-87.

"The numbers and proportion of tropical cyclones reaching categories 4 and 5 appear to have increased since 1970, while total numbers of cyclones and cyclone days decreased slightly in most basins (Webster et al., 2005). However, data quality and coverage issues, particularly prior to the satellite era, means that there is low confidence, as yet, in this assessment. Nevertheless the numbers of strong tropical cyclones in the North Atlantic (the best observed basin) have been above normal (based on 1981–2000) in nine of the last 11 years, culminating in the record breaking 2005 season. Globally, estimates of the potential destructiveness of hurricanes show a substantial upward trend since the mid-1970s, with a trend toward longer lifetimes and greater storm intensity (Emanuel, 2005)."

Seneviratne, S. I., Nicholls, N., Easterling, D., Goodess, C.M., Kanae, S., Kossin, J., … & Zhang, X. (2012). Changes in climate extremes and their impacts on the natural physical environment. In: Field, C.B et al. (Eds.), Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge, UK, and New York, NY, USA: Cambridge University Press, 109-230.

"The AR4 [IPCC Assessment Report 4] concluded (Meehl et al., 2007b) that a broad range of modeling studies project a likely increase in peak wind intensity and near-storm precipitation in future tropical cyclones. A reduction of the overall number of storms was also projected (but with lower confidence), with a greater reduction in weaker storms in most basins and an increase in the frequency of the most intense storms."

R8: SOUTHERN

Karl, T. R., Melillo, J. M., & Peterson, T. C. (2009). Global climate change impacts in the United States. New York, NY, USA: Cambridge University Press.

"The destructive potential of Atlantic hurricanes has increased since 1970, correlated with an increase in sea surface temperature. A similar relationship with the frequency of landfalling hurricanes has not been established (Emanuel, 2005; Hoyos et al, 2006; Mann and Emanuel, 2006; Trenberth and Shea, 2006)."

"An increase in average summer wave heights along the U.S. Atlantic coastline since 1975 has been attributed to a progressive increase in hurricane power.(Kunkel et al., 2008; Komar and Allan, 2007)"

"The intensity of Atlantic hurricanes is likely to increase during this century with higher peak wind speeds, rainfall intensity, and storm surge height and strength.(Meehl et al., 2007; Kunkel et al., 2008)."

McNulty, S. G. (2002). Hurricane impacts on us forest carbon sequestration. Environmental Pollution, 116, 817-824. doi:10.1016/S0269-7491(01)00242-1

"Hurricanes do not immediately change the state of carbon in downed wood. However, shortly after the biomass has been uprooted or broken off, it begins to decompose. The fine, high nitrogen content leaves are first decomposed, followed by branch, stem and roots. It is the relative proportion of the downed salvaged wood to down non-salvaged wood that will determine how much of the post-hurricane debris is lost from the carbon sequestration pool."

"Given that most of the downed wood is never salvaged, the debris and litter becomes fuel for wild fires during the following years. For example, following Hurricane Hugo, forest debris was 1.5–3 m deep in many areas (Miranda, 1996). In addition to the original damage caused by the hurricane, wildfires fueled by post hurricane slash posed a real threat to surviving vegetation."

"Following a hurricane, photosynthetic capacity can be reduced by 50% which could lead to a reduced in oleoresin flow (in pines), and increased susceptibility to insect attack (Fredericksen et al., 1995)."

"Hurricanes preferentially remove the most mature vegetation, and thus allow the potentially more productive forest understory to replace the overstory."

"Tree species with a greater proportion of total carbon biomass above ground and in leaf tissue are more susceptible to uprooting (King, 1986). The two ends of the species susceptibility to hurricane damage are loblolly pine (Pinus taeda) and Baldcypress (Taxodium distichum). Mature pines have closed, compact crown far from the ground, on stems with little taper. The pines often grow on sandy soils with poorly anchored root systems. Old growth baldcypress have a highly tapered trunk, is extremely well rooted, and has an open canopy. When both these southern Florida forest types were exposed to Hurricane Andrew in 1992, the pines experienced 25–40% damage while the bald cypress was less than 10% (Davis et al., 1996)."

Shepherd, J. M., Grundstein, A., & Mote, T. L. (2007). Quantifying the contribution of tropical cyclones to extreme rainfall along the coastal southeastern United States. Geophysical Research Letters, 34(23), L23810. doi:10.1029/2007GL031694

"The apparent increase in intense hurricane activity in the Atlantic basin is receiving considerable attention. It is reasonable to ask if more intense hurricane activity manifests itself in increased precipitation totals, which may signal an accelerated water cycle and more freshwater flux to ocean basins. However, more information is still required to understand the net contribution of tropical cyclones to ocean basins. We developed the millimeter-day (MD) as a metric to quantify the contribution of TCs [tropical cyclones] to extreme rainfall events. Our results [using satellite-derived rainfall datasets from the coastal southeastern United States] revealed extreme rainfall days or ‘‘wet millimeter days (WMDs)’’ are most likely in September and October during the peak of the hurricane season. Further, we found that major hurricanes are strongly correlated with the largest magnitude WMDs (e.g. cumulative daily rainfall event) during the TC season (1998– 2006)."

"The results [using satellite-derived rainfall datasets from the coastal southeastern United States, 1998-2006] suggest that TCs [tropical cyclones] can contribute a significant portion of rainfall in an ocean basin but an increase in major TCs may be apparent in extreme daily events rather than the cumulative seasonal totals. This may mean that a trend in TC-related rainfall may not be apparent if a weaker regime of storms like tropical depressions/storms are not increasing in frequency of occurrence."

R9: EASTERN

Leonard, J. & Law, K. (2012). Spatial and temporal variations in West Virginia's precipitation, 1931–2000. Southeastern Geographer, 52(1), 5-19.

"Using a conservative 200 km buffer first (see Matyas 2006), we observed several trends in the tropical cyclone data: 1) an increased number of tracks crossed the state; 2) an increased number of tracks fell within 200 km of the state; 3) tropical cyclones increasingly were fall events (SON [September, October, November]) for the state, with the same number, but slightly smaller percentage of summer (JJA [June, July, August]) storms; 4) the length of tropical cyclone tracks within 200 km of the state increased; and 5) the amount of time (as measured by the number of storm points) that tropical cyclones were within 200 km of the state increased (Table 3)."

NORTH ATLANTIC

Hamburg, S. P., Vadeboncoeur, M. A., Richardson, A. D., & Bailey, A. S. (2012). Climate change at the ecosystem scale: a 50-year record in New Hampshire. Climatic Change, pages 1-21. doi:10.1007/s10584-012-0517-2

"Easterling et al. (2000) and Schär et al. (2004) report evidence of increases in the frequency of extreme climate events globally and climate modeling indicates a likely increase in the frequency and intensity of extreme events at the extremes of previously established frequency distributions [including drought] in the northeastern U.S. (Wehner 2004; Tebaldi et al. 2006; Hayhoe et al. 2007)."

SOUTH ATLANTIC

Johnsen, K. H., Butnor, J. R., Kush, J. S., Schmidtling, R. C., & Nelson, C. D. (2009). Hurricane Katrina winds damaged longleaf pine less than loblolly pine. Southern Journal of Applied Forestry, 33(4), 178-181.

"In a study of the Hobcaw Forest in coastal South Carolina, after Hurricane Hugo, Gresham et al. (1991) reported that longleaf pine [Pinus palustris] suffered less damage than loblolly pine [Pinus taeda]. It was noted that species native to the coastal plain are possibly better adapted to the disturbance regimes found there; for example, longleaf pine, baldcypress (Taxodium distichum), and live oak (Quercus virginiana) suffered less damage than forest species with broad distribution ranges."

SOUTH CENTRAL

Johnsen, K. H., Butnor, J. R., Kush, J. S., Schmidtling, R. C., & Nelson, C. D. (2009). Hurricane Katrina winds damaged longleaf pine less than loblolly pine. Southern Journal of Applied Forestry, 33(4), 178-181.

"Mortality [from Hurricane Katrina winds in southeast Mississippi] generally increased with mean plot height, but at any given height, mortality was greatest in loblolly pine [Pinus taeda], followed by slash pine [Pinus elliotii] and lowest in longleaf pine [Pinus palustris] (Figure 3)."

"Damage to longleaf pine [Pinus palustris] from Hurricane Katrina was clearly the least severe, followed by slash [Pinus elliotii] and loblolly pines [Pinus taeda]. As this study [in southeast Mississippi] is replicated on one site, variation among neither soil conditions nor topography was responsible for differential species mortality. Other stand attributes do not appear to be responsible for the species differences."

Warner, N. N. & Tissot, P. E. (2012). Storm flooding sensitivity to sea level rise for Galveston Bay, Texas. Ocean Engineering, 44, 23-32.

"For events leading to smaller maximum water levels [in Galveston Bay, Texas] the increase is limited by a rapid rise to a 100% probability, i.e. the events are predicted to take place every year. The largest proportional increase is computed for a 1.1 m water level, which is predicted to occur 6.5 times as often in 2100. For events leading to larger surges, the relative exceedance probability ratio decreases progressively to about a factor 1.85 for the maximum water levels generated by 2008 Hurricane Ike."

"For the faster sea level rise scenario, by 2100 the maximum water level expected every year in Galveston [Bay, Texas] is greater than the water levels of all but four hurricanes from the historical record, while the return period of an event of the magnitude of Hurricane Ike is predicted to decrease to 29 years from presently 105 years. "

"By year 2100 water level exceedance probabilities [in Galveston Bay, Texas] are expected to double for the impact of the largest storms such as Hurricane Ike, but increase by a factor over six times for the impact of smaller storm surges associated locally with the impact of storms such as Hurricanes Cindy, Alicia, and Rita for the conservative scenario."

EAST

Biasutti, M., Sobel, A. H., Camargo, S. J., & Creyts, T. T. (2011) Projected changes in the physical climate of the Gulf Coast and Caribbean. Climatic Change, early online, 1-27. doi:10.1007/s10584-011-0254-y

"In the north Atlantic, in the decades since the 1970s (the best observed region and time period in the global TC record) there has been an increasing trend in the number of intense storms (Webster et al. 2005), as well as in the power dissipation index (PDI), a measure which combines the number, intensity, and lifetime of all storms in a season (Emanuel 2005)."

"Tropical cyclones [TC] form only in regions of relatively high sea surface temperature (SST). SST has long been recognized as one of the factors that influences both TC formation (Gray 1979) and the maximum intensity attainable by a mature TC (Emanuel 1987; Holland 1997). This relationship has spurred the concern that future SST increases in response to increased greenhouse gases will be associated with increases in the number and intensity of TCs. Yet, much of the observed relationship between SST and TC activity in the historical record can be explained as well or better by relative SST—the difference between the local SST at a given location and the tropical mean—than by absolute SST (Vecchi and Soden 2007b; Vecchi et al. 2008)."

"If the absolute value of SST were considered the primary variable controlling TC activity, one would expect dramatic increases in TC activity as the climate warms. On the other hand, the picture is very different if one considers relative SST to be the more relevant variable. There is no reason to expect that future changes in relative SST will be anywhere near as large as changes in absolute SST. Future SST patterns are projected to be broadly similar to those today (with changes in spatial structure that are significant, but still small compared to the mean change, as can be seen from Fig. 12), except warmer. If one were to assume that statistical relationships between relative SST and TC activity from the present will continue to hold in the future, one would then expect relatively little change in TC activity, as shown in Fig. 15 (Vecchi and Soden 2007b; Vecchi et al. 2008)."

"Results from studies with both of these new methodologies show considerable diversity, but also an emerging consensus on the broad outlines of the changes in global TC [tropical cyclone] activity that are expected in the warming climate. On average across the globe, assuming global climate changes within the range deemed most likely, the average intensity of tropical cyclones is expected to increase by 2–11% while the frequency of TC occurrence is expected to decrease by 6–34% (Knutson et al. 2010). This projected decrease in frequency of all storms (from tropical storm up to category 5 hurricane strength) is not comforting, because the frequency of the most intense storms in particular is projected to increase. The most intense storms produce by far the greatest damage."

Emanuel, K. (2005). Increasing destructiveness of tropical cyclones over the past 30 years. Nature, 436, 686-688. doi: 10.1038/nature03906

"The large increase in power dissipation over the past 30 yr or so may be because storms have become more intense, on the average, and/or have survived at high intensity for longer periods of time. The accumulated annual duration of storms in the North Atlantic and western North Pacific has indeed increased by roughly 60% since 1949, though this may partially reflect changes in reporting practices, as discussed in Methods. The annual average storm peak wind speed summed over the North Atlantic and eastern and western North Pacific has also increased during this period, by about 50%. Thus both duration and peak intensity trends are contributing to the overall increase in net power dissipation."

"In theory, the peak wind speed of tropical cyclones should increase by about 5% for every 1 °C increase in tropical ocean temperature (Emanuel 1987). Given that the observed increase has only been about 0.5 °C, these peak winds should have only increased by 2–3%, and the power dissipation therefore by 6–9%. When coupled with the expected increase in storm lifetime, one might expect a total increase of PDI [power dissipation index] of around 8–12%, far short of the observed change."

"In an effort to quantify a global signal, annual average smoothed SST [sea surface temperature] between 30°N and 30°S is compared to the sum of the North Atlantic and western North Pacific smoothed PDI [power dissipation index] values in Fig. 3. The two time series are correlated with an r 2 of 0.69. The upturn in tropical mean surface temperature since 1975 has been generally ascribed to global warming, suggesting that the upward trend in tropical cyclone PDI values is at least partially anthropogenic."

Galik, C. S. & Jackson, R. B. (2009). Risks to forest carbon offset projects in a changing climate. Forest Ecology and Management, 257(11), 2209-2216. doi:10.1016/j.foreco.2009.03.017

"A recent analysis suggested that a single event – Hurricane Katrina in 2005 – converted an equivalent of 50–140% of the average annual U.S. forest carbon storage rate into downed or dead biomass (Chambers et al., 2007). Hurricane intensity and destructive potential are likely to increase this century (Emanuel, 1987, 2005)."

Knutson, T. R., McBride, J. L., Chan, J., Emanuel, K., Holland, G., Landsea, C., Held, I., Kossin, J. P., Srivastava, A. K., & Sugi, M. (2010). Tropical cyclones and climate change. Nature Geoscience, 3(3), 157-163. doi:10.1038/ngeo779

"Based on existing modelling studies (Supplementary Table S1) and limited existing observations, we judge that it is likely that global mean tropical-cyclone-frequency will either decrease or remain essentially unchanged owing to greenhouse warming. Late twenty-first-century model projections indicate decreases ranging from −6 to −34% globally, with a comparatively more robust decrease for the Southern Hemisphere mean counts than for the Northern Hemisphere mean counts. Among the proposed mechanisms for the decrease in global tropical cyclone frequency is a weakening of the tropical circulation [Begtsson et al. 2007, Sugi et al. 2002] associated with a decrease in the upward mass flux accompanying deep convection33, or an increase in the saturation deficit of the middle troposphere [Emanuel et al. 2008]."

"Some increase in the mean maximum wind speed of tropical cyclones is likely with projected twenty-first century warming, although increases may not occur in all tropical regions."

"Studies based on potential intensity theory and the higher resolution (<20-km grid) models project mean global [tropical cyclone] maximum wind speed increases of +2 to +11% (roughly +3 to +21% central pressure fall; Supplementary Information S2) over the twenty-first century. At the individual basin scale, existing multimodel ensemble mean projections show a range of intensity changes from about −1 to +9%."

"Even a relatively small shift or expansion of the intensity distribution of storms towards higher intensities can lead to a relatively large fractional increase in the occurrence rate of the strongest (rarest) tropical cyclones. For example, a recent downscaling study [Knutson et al. 2008] using an operational (9-km grid) hurricane prediction model shows a tendency towards increased frequency of Atlantic Category 4 and 5 hurricanes over the twenty-first century."

"Tropical-cyclone-related rainfall rates are likely to increase with greenhouse warming. This is a robust projection in model simulations of tropical cyclones in a warmer climate: all seven available studies report substantial increases in storm-centred rainfall rates (Supplementary Information S3 and Supplementary Table S3). The range of projections for the late twenty-first century between existing studies is +3 to +37%."

"Changes in tropical cyclone storm-surge potential depend on future projections of sea-level rise — which are uncertain at the global scale [IPCC 2007] and in regional structure — as well as on storm characteristics. Even assuming no future changes in tropical cyclone behaviour, storm-surge incidence from tropical cyclones, the most damaging aspect of tropical cyclone impacts in coastal regions, would be expected to increase because of highly confident predictions that at least some future increase in sea level will occur [IPCC 2007]."

Mann, M. E., & Emanuel, K. A. (2006). Atlantic Hurricane Trends Linked to Climate Change. Eos, 87(24), 233-244. doi:10.1029/2006EO240001

"The linear correlation between the decadally smoothed series, $r = 0.73$ ($p < 0.001$ for decadally smoothed data, and a one-tailed hypothesis test), indicates that the overall trend and more than half of the total decadal variance in annual tropical cyclone counts can be resolved by SST [sea surface temperature] variations ($r = 0.61$; $p < 0.001$ is obtained if the bivariate statistical model for T(t) is used in place of T(t) itself). R(t), which must include any AMO [The multidecadal oscillatory pattern in Atlantic sea surface temperature] contribution, explains an insignificant four percent (Figure 2) of the decadal tropical cyclone variance ($r = 0.20$, $p > 0.1$ for a one-sided test). In other words, the SST variability underlying increased Atlantic tropical cyclone activity appears unrelated to the AMO."

O'Brien, S. T., Hayden, B. P., & Shugart, H. H. (1992). Global climatic change, hurricanes, and a tropical forest. Climatic Change, 22, 175-190.

"Wendland (1977) calculated that if the SST isotherm configuration remains similar, an increase in the SST of the tropical Atlantic of 1.1 °C could result in 19 Atlantic hurricanes per year."

"In addition to increasing the SST [sea surface temperature], global warming can be expected to lengthen the hurricane season. This adds to the potential number of hurricanes which can be expected in a given year."

"Emanuel (1987), using a Carnot cycle model and 2 x C02 equilibrium temperatures projected by the Goddard Institute for Space Studies GCM II, calculated that the maximum destructive potential of hurricanes can be expected to increase by 40% to 60%."